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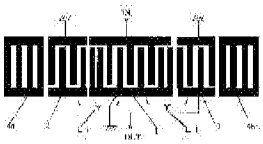
(54) ELASTIC SURFACE WAVE FILTER



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a means for widening the band width of a primary-tertiary longitudinally-coupled double mode elastic surface wave filter and also reducing the insertion loss.

SOLUTION: This longitudinally-coupled multiple module elastic wave filter is constituted by arranging a plurality of ID electrodes in the direction of propagation

of surface waves on the main surface of a piezoelectric substrate. In a section where adjacent IDT electrodes are adjoining each other, electrode fingers are disposed at narrower pitches than those of the electrode fingers in a section excluding the section where they are adjoining each other.

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CLAIMS

[Claim(s)]

[Claim 1] While arranging so that two or more IDT electrodes may be mutually approached along the propagation direction of a surface wave on the main front face of a piezo-electric substrate [near the contiguity section of the IDT electrode which is the vertical joint multiplex-mode surface acoustic wave filter which has arranged the grating reflector, and adjoined both the outsides of these IDT(s) electrode (adjoining section)] The surface acoustic wave filter characterized by arranging the electrode finger in the narrow pitch compared with the electrode finger pitch (Lt) of parts other than the adjoining section of an IDT electrode.

[Claim 2] The surface acoustic wave filter according to claim 1 characterized by being the primary 3rd [-] length joint dual mode surface acoustic wave filter which carried out contiguity arrangement and constituted three IDT electrodes on the main front face of a piezo-electric substrate.

[Claim 3] The surface acoustic wave filter according to claim 2 characterized by setting said adjoining section to the IDT electrode side arranged outside the IDT electrode arranged in the center widely.

[Claim 4] The surface acoustic wave filter according to claim 1 to 3 which makes the electrode finger number of said adjoining section four, and is characterized by the ratios Lt4/Lt of the electrode finger pitch Lt4 and electrode finger pitches Lt other than the adjoining section being 0.8000 <=Lt4/Lt<=0.9111.

[Claim 5] The surface acoustic wave filter according to claim 1 to 3 which makes the electrode finger number of said adjoining section eight, and is characterized by the ratios Lt8/Lt of the electrode finger pitch Lt8 and electrode finger pitches Lt other than the adjoining section being 0.8941 <=Lt8/Lt<=0.9530.

[Claim 6] The surface acoustic wave filter according to claim 1 to 5 with which

width of face of the electrode finger of said adjoining section and tooth-space width of face between electrode fingers are characterized by the equal thing.
[Claim 7] The surface acoustic wave filter according to claim 1 characterized by setting up the electrode finger pitch so that the electrode finger pitch of the central part of said adjoining section is the narrowest, and goes toward outside and electrode finger pitches other than the adjoining section may be approached.
[Claim 8] The surface acoustic wave filter according to claim 1 to 5 with which width of face of the electrode finger of said adjoining section and width of face of electrode fingers other than the adjoining section are characterized by the equal thing.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the SAW filter which has improved the bandwidth and the insertion loss of the primary 3rd [-] length joint dual mode SAW filter (a dual mode SAW filter is called hereafter) using the primary longitudinal mode [3rd] about a surface acoustic wave filter (an SAW

filter is called hereafter).

[0002]

[Description of the Prior Art] In recent years, especially many SAW filters to a portable telephone etc. are used from having the description which was used widely and was [nature / high performance, small, / mass-production] excellent in the communication link field. Contiguity arrangement of the three IDT electrodes is carried out, the primary longitudinal mode [3rd] is excited to stress, and the dual mode SAW filter of the broadband constituted using these is in one of the filters used for the RF section of a portable telephone also in it.

[0003] Drawing 14 is the top view showing the fundamental configuration of the conventional dual mode SAW filter, and it arranges the grating reflectors (a reflector is called hereafter) 15a and 15b in the both sides of these IDT(s) electrodes 12, 13, and 14, respectively while it carries out contiguity arrangement of the IDT electrodes 12, 13, and 14 along the propagation direction of a surface wave on the main front face of the piezo-electric substrate 11. And while the IDT electrodes 12, 13, and 14 are formed from the radial fin type electrode of the pair which has two or more electrode fingers put mutually in between, respectively, are the central IDT electrodes 12, while go away, and wirebonding etc. is used for an input terminal IN and they connect a form electrode to it, the radial fin type electrode of another side is grounded. furthermore, the IDT electrode 13 of both outsides -- while [connecting] going away 14 and connecting form electrodes, respectively, it connects with an output terminal OUT, another side is grounded, and a dual mode SAW filter is constituted.

[0004] As shown in drawing 15 , each of each electrode finger pitch of the IDT electrodes 12, 13, and 14 is set to Lt (it is lambda=2Lt when an electrode period is set to lambda), and the electrode finger pitch of Reflectors 15a and 15b is set to Lr. And as for the center-to-center spacing Ltr of the electrode fingers of the IDT electrodes 13 and 14 and Reflectors 15a and 15b which adjoin each other, it is common to set it as lambda/2 in consideration of the continuity of a surface acoustic wave. Moreover, as for the pitch Lr of Reflectors 15a and 15b, it is

common to set up so that the stop band Bs which these form may include the pass band B of the dual mode SAW filter which the primary mode [3rd] excited with the IDT electrodes 12, 13, and 14 forms. By considering as such a configuration, Q value in the primary mode [3rd] can be enlarged and flattening of a pass band and reduction of an insertion loss are attained as a filter.

[0005] Expansion of the bandwidth of RF filter came to be required that the number of channels held corresponding to the rapid spread of cellular phones should be increased in recent years. Although various improvements were made in order to fill this demand, it was experimentally found out by one of them by making smaller than lambda/2 center-to-center spacing Ltt of the electrode fingers of the central IDT electrode 12 and the IDT electrodes 13 and 14 of both outsides which adjoin each other, as shown in drawing 15 that the bandwidth of a dual mode SAW filter increases. Drawing 16 is the top view of the electrode pattern at the time of setting the ratio of an electrode digit (Rhine width of face) Ln and the tooth-space width of face St to 50:50 (Ln=St=lambda/4), and setting up Ltt with lambda/4, and is the electrode pattern Fig. where the electrodes of a central IDT electrode and the IDT electrode of both outsides which adjoin each other touched mutually. Since two electrode fingers touch in the boundary part of an adjacency IDT electrode and one electrode finger is constituted, the Rhine width of face becomes broad with lambda/2. Now, in order to attain maximization of the bandwidth of a dual mode SAW filter, it is common to set up the center-to-center spacing Ltt between 0.2lambda and 0.3lambda, and drawing 17 is an electrode pattern of a dual mode SAW filter generally used now. As shown in drawing 1717 , as for a broad electrode finger, it is desirable to arrange to the both ends of central IDT electrode 12', or to arrange to the innermost side of IDT electrode 13' of both outsides and 14', and to constitute in the symmetry to the core of central IDT electrode 12' as the whole electrode pattern.

[0006]

[Problem(s) to be Solved by the Invention] However, in the conventional dual mode SAW filter as shown in drawing 17 , since the broad electrode fingers Q1

and Q2 in the both ends of central IDT electrode 12' are set up more widely than other electrode digits (Rhine width of face), when electrode periods differ in the part, the continuity of the surface wave excited will be spoiled. Therefore, there was a problem that the insertion loss of a dual mode SAW filter could not be reduced. It is made in order that this invention may solve the above-mentioned problem, and while expanding bandwidth, it aims at offering the dual mode SAW filter which reduced the insertion loss.

[0007]

[Means for Solving the Problem] Invention of the surface acoustic wave filter applied to this invention in order to attain the above-mentioned purpose according to claim 1 While arranging so that two or more IDT electrodes may be mutually approached along the propagation direction of a surface wave on the main front face of a piezo-electric substrate [near the contiguity section of the IDT electrode which is the vertical joint multiplex-mode surface acoustic wave filter which has arranged the grating reflector, and adjoined both the outsides of these IDT(s) electrode (adjoining section)] It is the surface acoustic wave filter characterized by arranging the electrode finger in the narrow pitch compared with the electrode finger pitch (standard pitch: Lt) of parts other than the adjoining section of an IDT electrode. Invention according to claim 2 is a surface acoustic wave filter according to claim 1 characterized by being the primary 3rd [-] length joint dual mode surface acoustic wave filter which carried out contiguity arrangement and constituted three IDT electrodes on the main front face of a piezo-electric substrate. Invention according to claim 3 is a surface acoustic wave filter according to claim 2 characterized by setting said adjoining section to the IDT electrode side arranged outside the IDT electrode arranged in the center widely. Invention according to claim 4 makes the electrode finger number of said adjoining section four, and is the ratio of the electrode finger pitch Lt4 and electrode finger pitches Lt other than the adjoining section. It is the surface acoustic wave filter according to claim 1 to 3 characterized by Lt4/Lt being 0.8000 <=Lt4/Lt<=0.9111. Invention according to claim 5 is a surface acoustic

wave filter according to claim 1 to 3 which makes the electrode finger number of said adjoining section eight, and is characterized by the ratios Lt8/Lt of the electrode finger pitch Lt8 and electrode finger pitches Lt other than the adjoining section being 0.8941 <=Lt8/Lt<=0.9530. Invention according to claim 6 is a surface acoustic wave filter according to claim 1 to 5 with which width of face of the electrode finger of said adjoining section and tooth-space width of face between electrode fingers are characterized by the equal thing. Its electrode finger pitch of the central part of said adjoining section is the narrowest, and invention according to claim 7 is a surface acoustic wave filter according to claim 1 characterized by setting up the electrode finger pitch so that electrode finger pitches other than the adjoining section may be approached, so that it goes toward outside. Invention according to claim 8 is a surface acoustic wave filter according to claim 1 to 5 with which width of face of the electrode finger of said adjoining section and width of face of electrode fingers other than the adjoining section are characterized by the equal thing.

[0008]

[Embodiment of the Invention] This invention is explained to a detail based on the gestalt of operation shown in the drawing below. Drawing 1 is the top view showing the electrode pattern configuration of the dual mode SAW filter concerning this invention, and it arranges Reflectors 4a and 4b in those both sides while it carries out contiguity arrangement of the three IDT electrodes 1, 2, and 3 along the propagation direction of SAW on a piezo-electric substrate (not shown). The IDT electrodes 1, 2, and 3 are formed from the radial fin type electrode of the pair which has two or more electrode fingers put mutually in between, respectively, and they ground the radial fin type electrode of another side while they are the central IDT electrodes 1, while go away and connect a form electrode to an input terminal IN. furthermore, the IDT electrode 2 of both outsides -- while [connecting] going away three and connecting form electrodes, respectively, it connects with an output terminal OUT, another side is grounded, and a dual mode SAW filter is constituted. The dual mode SAW filter of this

invention is constituted by the symmetry to the core of the central IDT electrode 1.

[0009] The description of this invention is in the place where the bandwidth of a dual mode SAW filter becomes large at, and an insertion loss is reduced by having set near [which adjoins each other] the central IDT electrode 1 and the IDT electrodes 2 and 3 of both outsides (the adjoining section being called hereafter) (i.e., the section shown in drawing 1 by Li), and having made the electrode finger pitch narrower than electrode finger pitches other than the adjoining section.

[0010] The important section of this invention is explained using a drawing. drawing 2 -- (-- a --) -- drawing 17 -- having been shown -- the former -- the dual mode -- an SAW filter -- an electrode -- a pattern -- a center -- IDT -- an electrode -- 12 -- ' -- an outside -- IDT -- an electrode -- 14 -- ' -- contiguity -- the section -- expanding -- having been shown -- a top view -- said -- drawing -- (-- b --) -- the -- a sectional view -- void -- an electrode -- a finger -- for example, -- (-- + --) -- a side -- ** -- carrying out -- a pattern -- it is -- an electrode -- a finger -- the (-) side -- carrying out . drawing 2 -- (-- a --) -- being shown -- as -- a center -- IDT -- an electrode -- 12 -- ' -- broad -- an electrode -- a finger -- f -- two -- a center -- receiving -- the symmetry -- f -- one -- from -- f -- three -- up to -- three -- a ** -- an electrode -- a finger -- choosing -- this -- an electrode -- **** -- both sides -- it is -- an electrode -- a finger -- fa -- a right end -- a location -- from -- IDT -- an electrode -- 14 -- ' -- an electrode -- a finger -- fb -- a left end -- a location -- up to -- this section -- L4 -- carrying out . Here, the adjoining section will be chosen as bilateral symmetry from the core of the broad electrode finger f2 that the continuity of a surface acoustic wave collapses. Moreover, electrode finger pitches other than the adjoining section are set to Lt. It replaces with three electrode fingers f1, f2, and f3 in this adjoining section L4, and as shown in drawing 2 (c), four electrode fingers F1, F2, F3, and F4 are newly formed in the equal electrode finger pitch Lt4. It is set to Lt4<Lt with a natural thing. Drawing 2 (d) expresses the sectional view and polarity of this drawing (c). Thus, when four electrode fingers of an equal electrode finger pitch permute the adjoining section

L4, the continuity of a surface acoustic wave is improved.

[0011] The above example is an example which permuted the Rhine-tooth-space ratio which replaced with three electrode fingers in the adjoining section of IDT electrodes shown in drawing 17 , and was newly formed with four electrode fingers set to 1:1. The continuity of the surface wave of what can extend a pass band will be spoiled by having constituted equally the electrode finger pitches Lt and Ltt which carry out basic form (drawing 15) continuation, as it indicated drawing 18 (a) that this was described previously, and having carried out contiguity arrangement of the IDT electrodes which adjoin each other as shown in this drawing (b), although it had become the structure which a surface wave can spread continuously. Then, when the amount (Lt-Ltt) in which the electrode finger pitch narrowed is made into the amount Lof of offset, the description of this invention is in the place which has improved the continuity of a surface wave by distributing the electrode finger of a ** pitch equally at the adjoining section L4 rather than arranging concentration, now one broad electrode finger for the amount Lof of offset to one place.

[0012] The filter shape shown with the broken line of drawing 3 is a pass band property at the time of making RF filter for PDC (low frequency RF filter of the dual filter for PDC) as an experiment using the electrode pattern of the former (drawing 17). 39-degreeY-X LiTaO3 is used for a piezo-electric substrate. Center frequency 877.5MHz, It is set as the bandwidth of 15MHz. The logarithm of lambda/4 and central IDT electrode 12' for 50:50 and the electrode finger center-to-center spacing Ltt 28.5 pairs, [the ratio of an electrode finger and a tooth space] They are IDT electrode 13' of both outsides, and the case where the number of 33lambda (lambda is an electrode period) and reflector 15 'a, 15' b is made [both the logarithms of 14'] into 90 for 19.5 pairs and the decussation length W, respectively. On the other hand, the filter shape shown as a continuous line is a pass band property at the time of permuting three electrode fingers which were in the adjoining section L4 as shown in drawing 2 (c) and (d) in four electrode fingers and tooth space which were formed in the equal electrode

finger pitch Lt4. Pitch ratio alpha=Lt 4 of four newly formed electrode fingers/Lt is set to alpha= 0.8773. Furthermore, when this invention was applied, it became clear that broadband-ization of pass band width was realizable not only in the range of 0.2 lambda<=Ltt <=0.3lambda generally used until now as electrode finger spacing Ltt of the dual mode SAW filter made into criteria but the range of 0.1 lambda<=Ltt <=0.3lambda. Therefore, the range which can be set up as pitch ratio [of an electrode finger] alpha in this example is set to 0.8000<=alpha<=0.9111. While bandwidth spread compared with the conventional filter, as for the dual mode SAW filter which becomes the 1st example, it became clear that an insertion loss was reduced, so that clearly from drawing 3 .

[0013] The filter shape shown with the broken line of drawing 4 is a pass band property at the time of making RF filter for AMPS as an experiment using the electrode pattern of the former (drawing 17). 39-degreeY-X LiTaO3 is used for a piezo-electric substrate. Center frequency 881.5MHz, It is set as the bandwidth of 25MHz. 50:50 and the electrode finger center-to-center spacing Ltt for the ratio of the Rhine width of face and a tooth space 0.3lambda, The logarithm of central IDT electrode 12' 19.5 pairs, IDT electrode 13' of both sides, It is a filter shape at the time of carrying out two-step cascade connection of the dual mode SAW filter which made [the logarithm of 14'] the number of 45lambda (lambda is an electrode period) and reflector 15 'a, 15' b 120 for 13.5 pairs and the decussation length W, respectively. On the other hand, the pass band property shown as a continuous line is a filter shape at the time of carrying out two-step cascade connection of the dual mode SAW filter which permuted the adjoining section L4 in four electrode fingers and tooth space of the equal electrode finger pitch Lt4 as shown in drawing 2 (c) and (d). Pitch ratio alpha=Lt 4 of four newly formed electrode fingers/Lt is alpha= 0.889. Expansion of bandwidth and reduction of an insertion loss can be checked as effectiveness of this invention also from drawing 4 .

[0014] drawing 5 -- this invention -- starting -- the -- two -- operation -- a gestalt --

being shown -- an example -- it is -- drawing 5 -- (-- a --) -- drawing 17 -- having been shown -- the former -- the dual mode -- an SAW filter -- a center -- IDT -- an electrode -- 12 -- ' -- an outside -- IDT -- an electrode -- 14 -- ' -- an important section -- expanding -- having been shown -- an electrode -- a pattern -- a top view -- said -- drawing -- (-- b --) -- the sectional view -- it is . drawing 5 -- (-- a --) -- being shown -- as -- a center -- IDT -- an electrode -- 12 -- ' -- broad -- an electrode -- a finger -- f -- four -- a center -- criteria -- ** -- carrying out -- the symmetry -- f -- one -- from -- f -- seven -- up to -- seven -- a ** -- an electrode -- a finger -- choosing -- this -- an electrode -- **** -- both sides -- it is -- an electrode -- a finger -- fa -- a right end -- a location -- from -- IDT -- an electrode -- 14 -- ' -- an electrode -- a finger -- fb -- a left end -- a location -- up to -- the section -- L8 -- carrying out -- . Selection of the adjoining section L8 shall be made into the core of the broad electrode finger f4, and shall be chosen as bilateral symmetry. It replaces with seven electrode fingers within [L8] this adjoining section, and eight electrode fingers F1, F2, F3, F4, F5, F6, F7, and F8 of the equal electrode finger pitch Lt8 are formed. Drawing 5 (d) expresses the sectional view and polarity of this drawing (c). Thus, by replacing with by electrode **** of pitches [electrode / of the adjoining section L8 containing ****], it is expected that the continuity of the surface acoustic wave in the adjoining section L8 will be improved, and the insertion loss of a filter will be improved.

[0015] The filter shape shown with the broken line of drawing 6 is the property of the filter at the time of making RF filter for PDC as an experiment using the electrode pattern of the former (drawing 17), and many constants shown in drawing 3 are used for it. The filter shape shown as the continuous line of this drawing shows the pass band property at the time of permuting by eight electrode **** of the equal electrode finger pitch Lt8 while increasing one electrode finger at the adjoining section L8 when an IDT electrode comrade adjoins each other, as shown in drawing 5 (c) and (d). Pitch ratio alpha=Lt 8 of an electrode finger/Lt is 0.9235. If spacing Ltt between electrode fingers of the dual mode SAW filter used as criteria is set to 0.1lambda<=Ltt<=0.3lambda as

mentioned above, the range which pitch ratio alpha of an electrode finger can set up will be set to 0.8941 <=Lt8/Lt<=0.9530. Compared with the conventional dual mode SAW filter (broken line), a filter shape passband is also known by reducing breadth and an insertion loss by the dual mode SAW filter (continuous line) of the 2nd example so that clearly from drawing 6 . Moreover, the filter of the pass band permuted with eight electrode fingers when drawing 3 was compared with 6 was larger than four things, and it became clear that the insertion loss was small. It is guessed that this is that by which the continuity of a surface wave has been improved more.

[0016] Drawing 7 shows the gestalt of the 3rd example to an upper case with a sectional view for the conventional example (drawing 17) at the lower berth. A total of nine [every four electrode fingers / of the same number] are chosen as right and left among drawing focusing on the broad electrode finger f5, and the section from the location at the left end of the electrode finger f1 in the both sides of this electrode **** to the location at the right end of the electrode finger f9 is set to L10. It replaces with nine electrode fingers of f9 from the electrode finger f1 in this adjoining section L10, and ten electrode fingers of F10 are newly formed from the electrode finger F1. The electrode finger pitch chooses it out of right and left of the adjoining section L10 as the symmetry with pitches p1, p2, and p3, its electrode finger pitch of p1>p2>p3 and a central part is the narrowest, and it sets an electrode finger pitch as it so that it goes to ** shown in the lower berth of drawing 7 toward outside, and electrode finger pitches other than the adjoining section may be approached. It sets up so that it may specifically become a V character mold, a U character mold, or a reverse trapezoid mold (p1>p2=p3). To electrode pitches Lt other than adjoining section L10, the continuity of a surface acoustic wave is spoiled and the direction set up so that change of adjoining section L10 pitch pi may decrease as much as possible is conjectured that there is also nothing.

[0017] The filter shape shown with the broken line of drawing 8 is a pass band property at the time of making RF filter for PDC (high frequency RF filter of a

PDC dual filter) as an experiment using the electrode pattern of the conventional example (drawing 17). 39-degreeY-X LiTaO3 is used for a piezo-electric substrate. Center frequency 1489.0 MHz, It is set as the bandwidth of 24MHz. 60:40 and the electrode finger center-to-center spacing Ltt for the ratio of Rhine and a tooth space 0.3lambda, It is a filter shape at the time of making [the logarithm of central IDT electrode 12' / the logarithm of 22.5 pairs, IDT electrode 13' of both sides, and 14'] the number of 30lambda (lambda is an electrode period) and reflector 15 'a, 15' b into 90 for 15.5 pairs and the decussation length W, respectively. On the other hand, the pass band property shown as a continuous line is a pass band property when ten electrode fingers formed in the electrode finger pitch pi (2 i= 1, 3) permute nine electrode fingers within the adjoining section L10, as shown in the lower berth of drawing 7 . The electrode finger pitches p1, p2, and p3 can be expressed as pi=alpha i-Lt using electrode finger pitch ratio alphai to the original electrode finger pitch Lt. the example of drawing 8 -- pitch ratio alphai -- reverse trapezoidal shape -- respectively -- 0.9667 and 0. -- it was referred to as 9333 and 0.9333. As change of a pitch, V typeface (a primary type, |a(x-b) |), U typeface (a secondary type, a(x-b) 2), etc. can be considered in addition to this. While bandwidth spread compared with the conventional filter, as for the dual mode SAW filter of this invention, it turned out that an insertion loss is reduced, so that clearly from drawing 8 R> 8.

[0018] Drawing 9 is drawing showing the gestalt of the 4th example, and the conventional example (drawing 17) and this drawing (b) where this drawing (a) serves as criteria, and (c) are the sectional view showing the configuration of the electrode pattern of the 4th example, and a top view. Although it considered as the adjoining section which increases one electrode finger and the adjoining section was decided to be bilateral symmetry focusing on the broad electrode finger in the old example, it is the example chosen so that how to choose the core of the adjoining section in this example might be shifted to the direction of an outside IDT electrode from a broad core and many electrode fingers of an outside IDT electrode might be included. drawing 9 -- (-- a --) -- being shown -- as

-- a center -- IDT -- an electrode -- 12 -- ' -- an electrode -- a finger -- fa -- a right end -- a location -- from -- an outside -- IDT -- an electrode -- 14 -- ' -- an electrode -- a finger -- fb -- a left end -- a location -- up to -- the section -- L4 -- carrying out . The broad electrode finger f1 and the electrode fingers f2 and f3 of the electrode finger pitch Lt are within this adjoining section L4, it replaces with these three electrode fingers f1, f2, and f3, and four electrode fingers F1, F2, F3, and F4 of the equal electrode finger pitch Lt4 are formed. It is set to Lt4<Lt with a natural thing, and an electrode finger pitch ratio is set to alpha4=Lt4/Lt<1.

[0019] A showing [the broken line of drawing 10] filter shape is the pass band property of the dual mode SAW filter constituted from a four equal electrode fingers pitch concerning this invention shown in drawing 2 R> 2 (c) and (d), and many constants used the constant shown in drawing 4 . The filter shape shown as the continuous line of this drawing is the thing of the dual mode SAW filter using the 4th example, and it is a pass band property at the time of removing three, increasing one electrode finger which existed in the adjoining section L4 as shown in drawing 9 (b) and (c), and forming four electrode fingers in an equal pitch. although the ripple has arisen in the pass band since the terminal impedance is carrying out mismatching -- an electrode -- a pass band can be made flat by setting up a logarithm proper. The adjoining section which narrows an electrode finger pitch like does not necessarily need to choose a broad electrode finger as the symmetry as a core, and may incline toward this example to the direction of the IDT electrode of outside approach.

[0020] Drawing 11 (a) is the sectional view showing the electrode pattern of the dual mode SAW filter of the former (drawing 17) used as criteria, and (b) is the sectional view of the electrode pattern in which the gestalt of the 5th example concerning this invention is shown. The section to a location is set to L3 at the right end of the electrode finger f3 from a left end location a core [the broad electrode finger of drawing 11 (a)] at the neighboring electrode fingers f1. It replaces with three electrode fingers f1, f2, and f3 in this adjoining section L3, and four electrode fingers F1, F2, F3, and F4 are newly formed. The Rhine width

of face considers any electrode finger as as [the original Rhine width of face Ln], and the electrode finger f1 is set to F1 as it is, and sets the electrode finger f3 to F4 as it is. And it replaces with the electrode finger f2, and arranges in pitches [fingers / F2 and F3 / of the Rhine width of face Ln / two / electrode]. So, the tooth space S2 between electrode fingers becomes narrow compared with the tooth-space width of face St of criteria. That is, S2 can be calculated from a degree type.

3S2=2St+ (Ltt-lambda/4) ..... (1)

That is, three places are made to distribute what the conventional offset was concentrating on one place, and an improvement of the continuity of a surface wave is aimed at.

[0021] The filter shape shown with the broken line of drawing 12 is a pass band property at the time of making RF filter for AMPS as an experiment using the electrode pattern of the former (drawing 17). 39-degreeY-X LiTaO3 is used for a piezo-electric substrate. Center frequency 881.5MHz, It is set as the bandwidth of 25MHz. 50:50 and the electrode finger center-to-center spacing Ltt for the ratio of an electrode finger and a tooth space 0.3lambda, The logarithm of central IDT electrode 12' 19.5 pairs, IDT electrode 13' of both sides, It is the pass band property of the filter which carried out two-step cascade connection of the dual mode SAW filter which made [the logarithm of 14'] the number of 45lambda (lambda is an electrode period) and reflector 15 'a, 15' b 120 for 13.5 pairs and the decussation length W, respectively. On the other hand, the filter shape shown as a continuous line is the pass band property of the filter which carried out two-step cascade connection of the dual mode SAW filter which set electrode finger pitch L't4 of the adjoining section L3 to 0.425lambda as shown in drawing 11 (b) after setting electrode finger spacing Ltt of criteria to 0.275lambda. A tooth space S2 is set to 0.175lambda here. Expansion of bandwidth and the reduction of an insertion loss which are the effectiveness of this invention are clear also from drawing 12 . Moreover, drawing 13 is drawing showing the filter shape of a decay area, and, as for a broken line, the property of the filter of the former (drawing

17) and a continuous line show the filter shape of this invention. It turns out that the property of the filter of this invention is improved a little at the low-pass side.
[0022]
[Effect of the Invention] This invention expresses the outstanding effectiveness of reducing an insertion loss while the pass band width spreads in the dual mode SAW filter concerning this invention, since it constituted as explained above.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the top view showing the configuration of the electrode pattern of the dual mode SAW filter concerning this invention.
[Drawing 2] The expansion top view where (a) and (b) become the criteria and sectional view of the important section of the conventional dual mode SAW filter, (c), and (d) are the expansion top views and sectional views of the important section of the 1st example concerning this invention.
[Drawing 3] It is the pass band property of RF filter for PDC made as an experiment using the electrode pattern of the 1st example concerning this invention.

[Drawing 4] It is the pass band property of RF filter for AMPS made as an experiment using the electrode pattern of the 1st example concerning this invention.

[Drawing 5] The expansion top view where (a) and (b) become the criteria and sectional view of the important section of the conventional dual mode SAW filter, (c), and (d) are the expansion top views and sectional views of the important section of the 2nd example concerning this invention.

[Drawing 6] It is the pass band property of RF filter for PDC made as an experiment using the electrode pattern of the 2nd example.

[Drawing 7] An upper case is the expanded sectional view of the important section of the conventional dual mode SAW filter used as criteria, and the lower berth is the expanded sectional view of the important section of the 3rd example concerning this invention.

[Drawing 8] It is the pass band property of RF filter for PDC made as an experiment using the electrode pattern of the 3rd example.

[Drawing 9] The expanded sectional view of the important section of the conventional dual mode SAW filter from which (a) becomes criteria, (b), and (c) are the 4th expanded sectional view and top view of an important section of an example concerning this invention.

[Drawing 10] The pass band property of the filter which made the continuous line as an experiment using the electrode pattern of the 4th example, and a broken line are the pass band properties of the filter made as an experiment using the electrode pattern of the 1st example shown in drawing 2 .

[Drawing 11] The expanded sectional view of the important section of the conventional dual mode SAW filter from which (a) becomes criteria, and (b) are the expanded sectional views of the important section of the 5th example concerning this invention.

[Drawing 12] The pass band property of the filter made as an experiment using the electrode pattern of the 5th example which a continuous line requires for this invention, and a broken line are the pass band properties when using the

conventional electrode pattern.

[Drawing 13] The decay area property of the filter made as an experiment using the electrode pattern of the 5th example which a continuous line requires for this invention, and a broken line are the decay area properties when using the conventional electrode pattern.

[Drawing 14] It is the top view of the basic electrode pattern in which the configuration of the conventional dual mode SAW filter is shown.

[Drawing 15] It is drawing showing the dimension of each part of the basic electrode pattern in which the configuration of the conventional dual mode SAW filter is shown.

[Drawing 16] It is the electrode pattern Fig. showing the configuration of the conventional dual mode SAW filter constituted that pass band width should be expanded.

[Drawing 17] It is the electrode pattern Fig. showing the configuration of the conventional dual mode SAW filter which presented practical use with drawing 16 .

[Drawing 18] (a) shows the sectional view of the electrode pattern at the time of expanding the sectional view and bandwidth which show the electrode pattern of the basic form of the conventional dual mode SAW filter, and the dimension of each part.

[Description of Notations]

1, 2, 3 .. IDT electrode

4a, 4b .. Reflector

Li, L3, L4, L8, L10 .. The adjoining section when two IDT electrodes adjoin

fa, fb, f1, f2f3, f4, f5, f6, f7, f8, f9 .. Electrode finger

F1, F2, F3, F4, F5, F6, F7, F8, F9, F10 .. Electrode finger

p1, p2, p3 .. Pitch of an electrode

S2 .. Tooth space

[Translation done.]

* NOTICES *

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damages caused by the use of this translation.

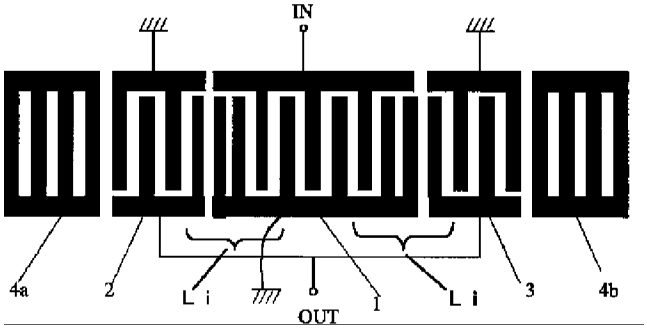
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

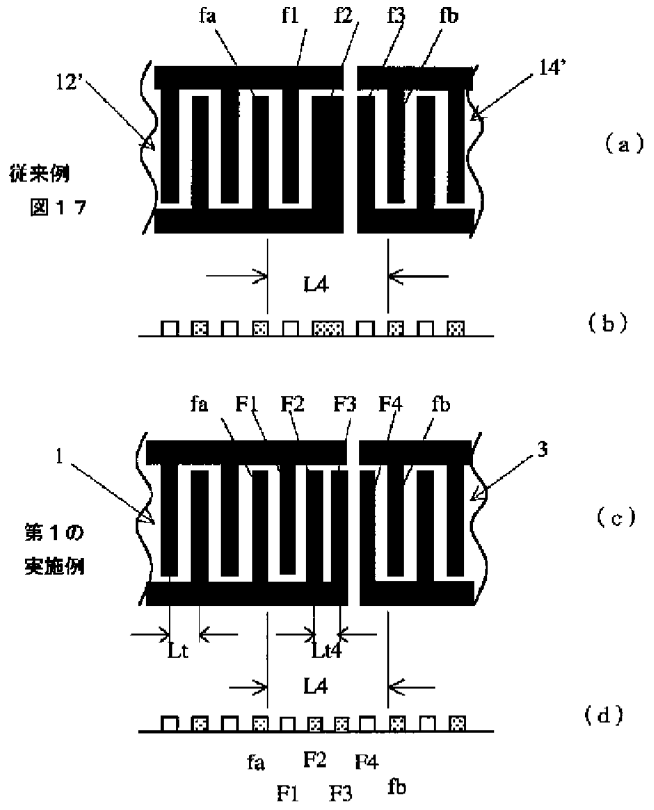
3.In the drawings, any words are not translated.

DRAWINGS

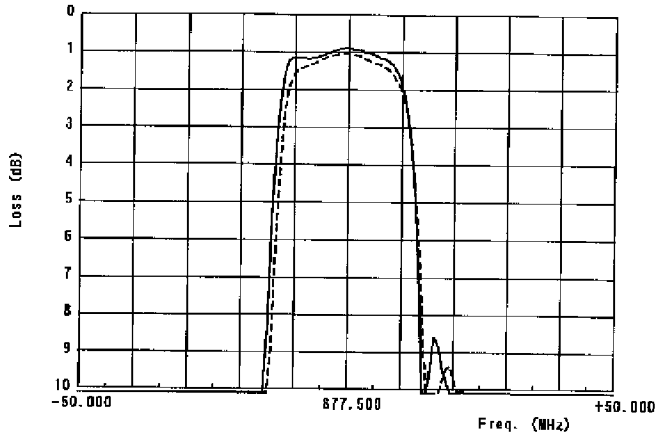
[Drawing 1]



[Drawing 2]



[Drawing 3]



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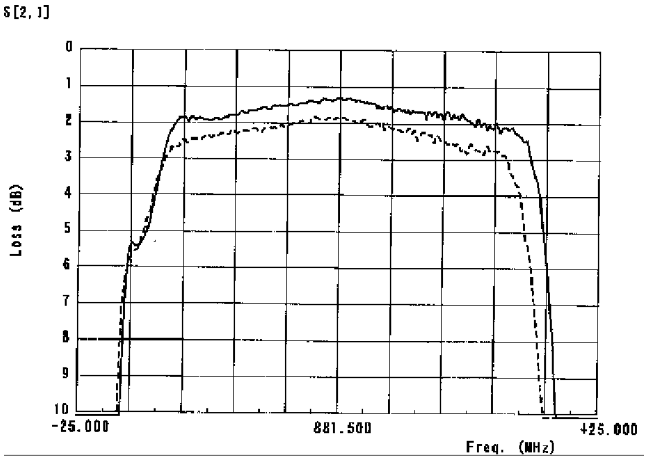
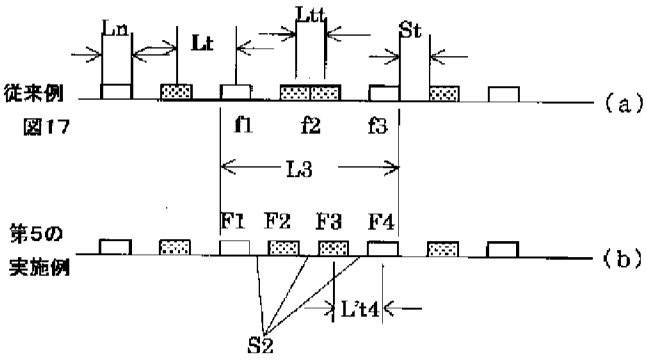
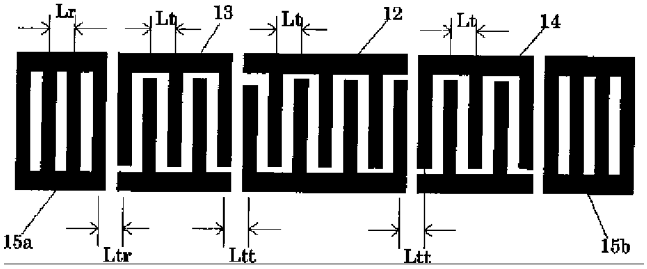


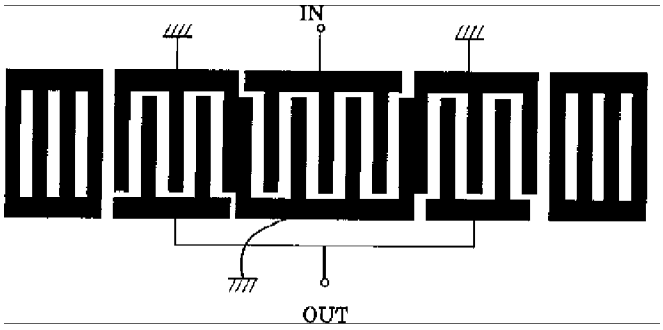
[Drawing 11]



[Drawing 15]



[Drawing 16]



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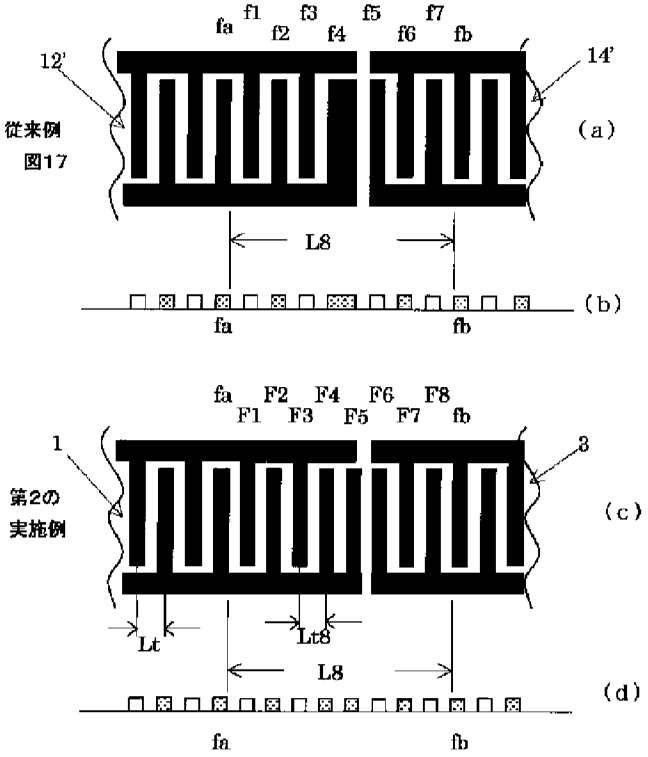

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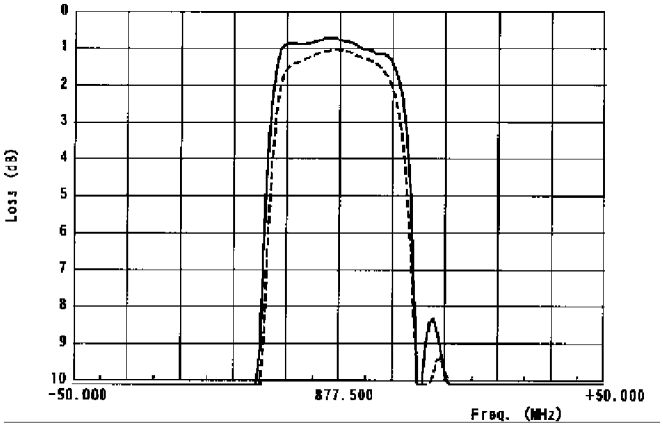

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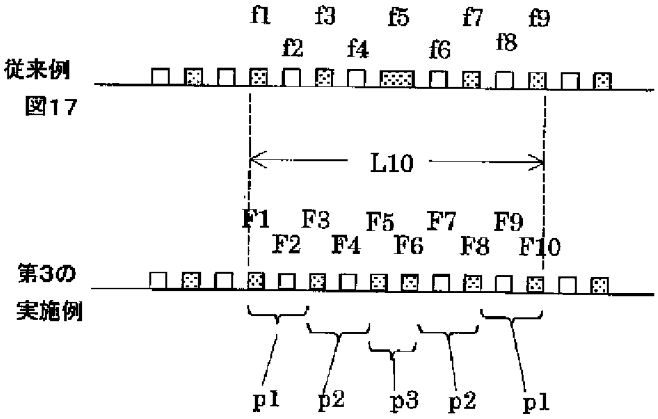

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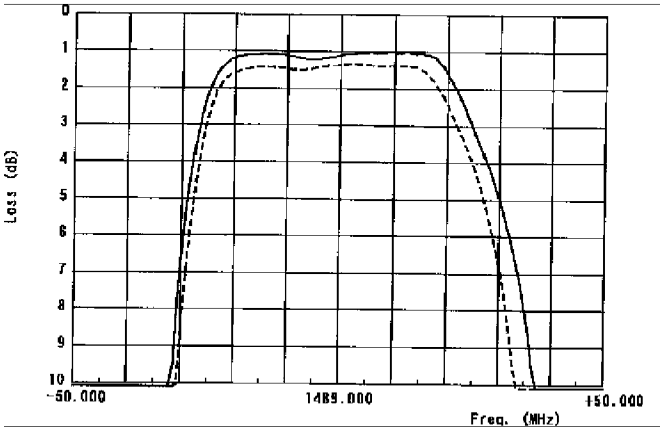

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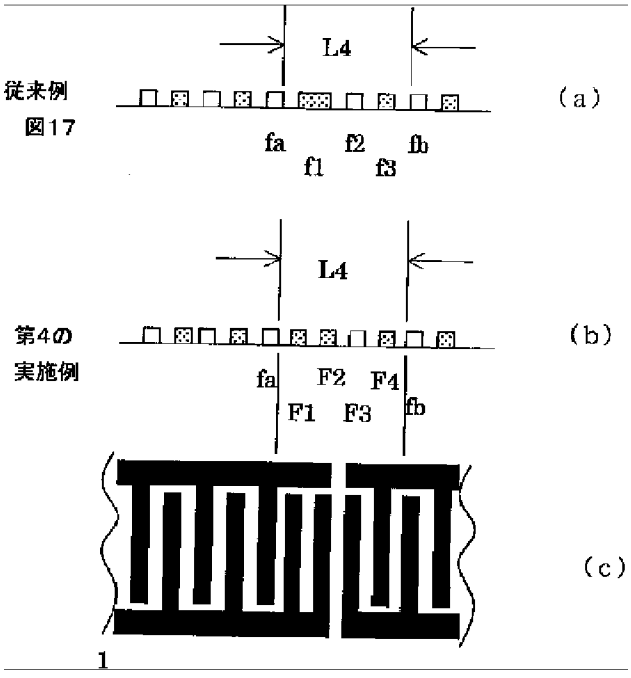
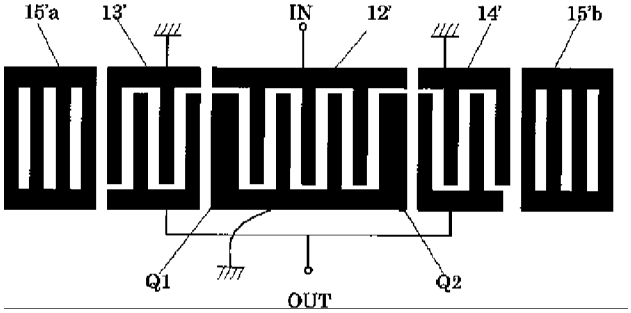
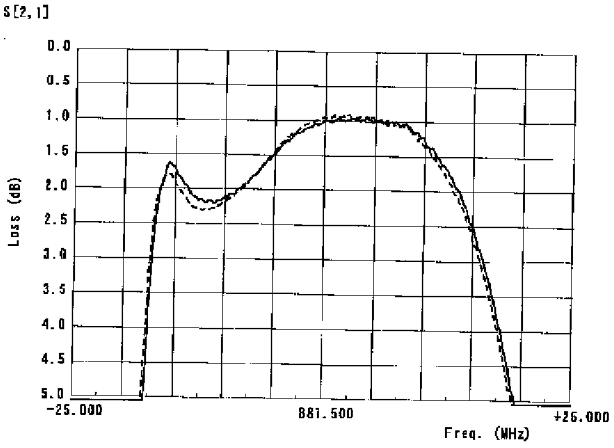


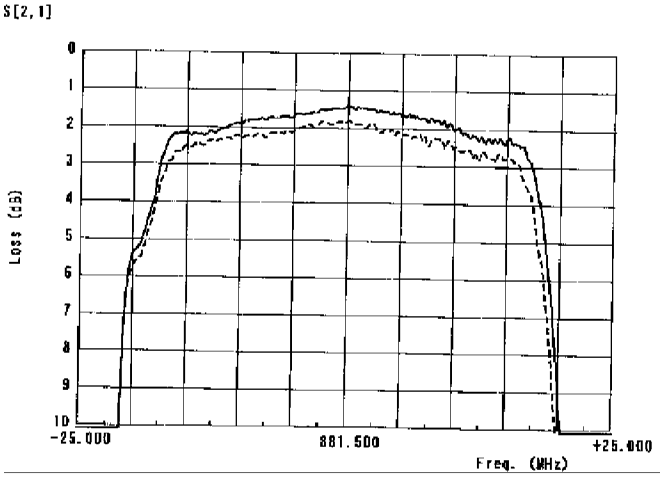
[Drawing 17]



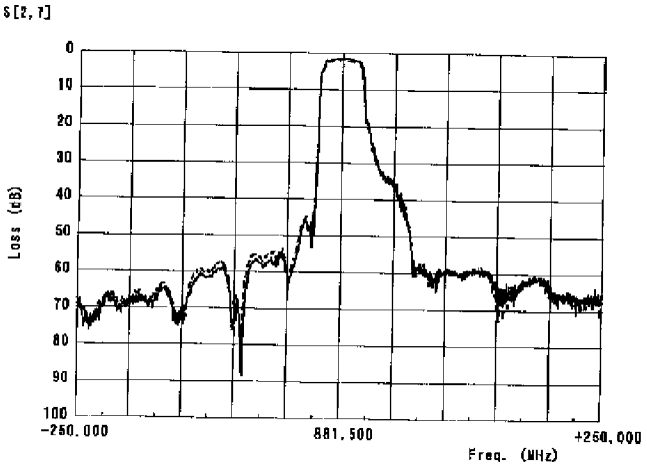
[Drawing 10]



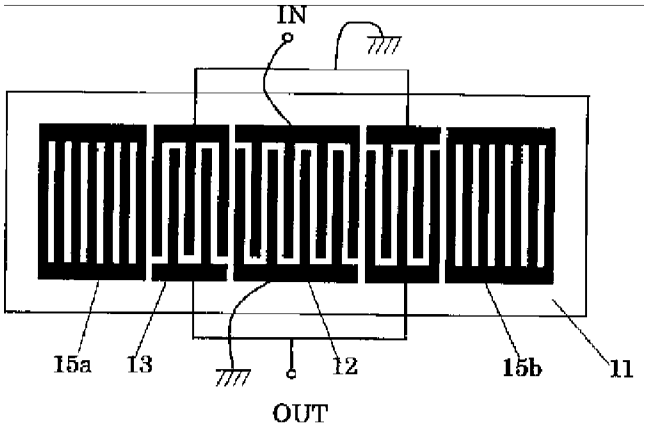
[Drawing 12]



[Drawing 13]



[Drawing 14]



[Drawing 18]

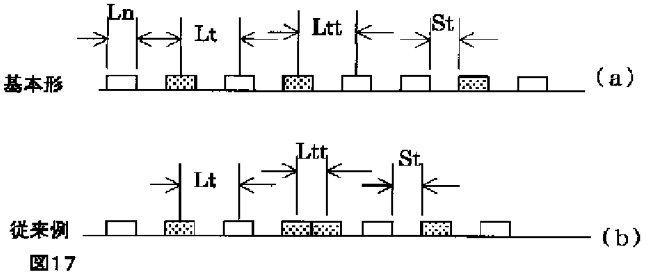


図17

[Translation done.]

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			Ａ	
9/64		9/64	Ｚ	

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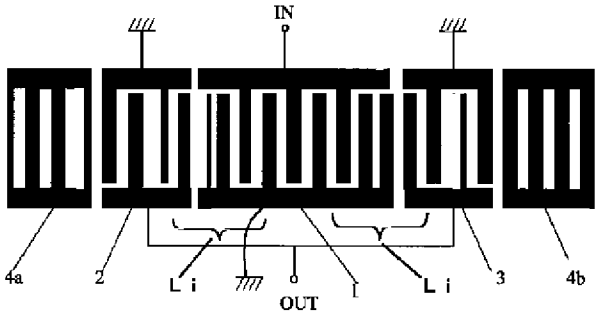
東洋通信機株式会社内

Ｆターム(参考)　5J097 AA01 AA19 BB03 BB14 DD07
GC03 KK04

(54)【発明の名称】　弾性表面波フィルタ

(57)【要約】
【課題】　１次－３次縦結合二重モード弾性表面波フィルタの帯域幅を広げると共に、挿入損失を低減する手段を得る。
【解決手段】　圧電基板の主表面上に表面波の伝搬方向に沿って複数のＩＤＴ電極を配置してなる縦結合多重モード弾性表面波フィルタであって、相隣接したＩＤＴ電極の隣接部区間において、該隣接区間以外の部分の電極指ピッチに比べ狭いピッチにて電極指が配列するように弾性表面波フィルタを構成する。



【特許請求の範囲】
【請求項１】　圧電基板の主表面上に表面波の伝搬方向に沿って複数のＩＤＴ電極を互いに近接するよう配置すると共に、これらＩＤＴ電極の両外側にグレーティング反射器を配置した縦結合多重モード弾性表面波フィルタであって、
相隣接したＩＤＴ電極の隣接部近傍（隣接区間）においては、ＩＤＴ電極の隣接区間以外の部分の電極指ピッチ（Ｌｔ）に比べ狭いピッチにて電極指が配列されていることを特徴とする弾性表面波フィルタ。
【請求項２】　圧電基板の主表面上に３つのＩＤＴ電極を近接配置して構成した１次－３次縦結合二重モード弾性表面波フィルタであることを特徴とする請求項１記載の弾性表面波フィルタ。
【請求項３】　中央に配置されたＩＤＴ電極よりも外側に配置されたＩＤＴ電極側に広く前記隣接区間が設定されていることを特徴とする請求項２記載の弾性表面波フィルタ。
【請求項４】　前記隣接区間の電極指本数を４本とし、その電極指ピッチＬｔ４と隣接区間以外の電極指ピッチＬｔとの比Ｌｔ４／Ｌｔが０．８０００≦Ｌｔ４／Ｌｔ≦０．９１１１であることを特徴とする請求項１乃至３記載の弾性表面波フィルタ。
【請求項５】　前記隣接区間の電極指本数を８本とし、その電極指ピッチＬｔ８と隣接区間以外の電極指ピッチＬｔとの比Ｌｔ８／Ｌｔが０．８９４１≦Ｌｔ８／Ｌｔ≦０．９５３０であることを特徴とする請求項１乃至３記載の弾性表面波フィルタ。
【請求項６】　前記隣接区間の電極指の幅と電極指間のスペース幅とが等しいことを特徴とする請求項１乃至５記載の弾性表面波フィルタ。
【請求項７】　前記隣接区間の中央部分の電極指ピッチが最も狭く、外に向かって行くほど隣接区間以外の電極指ピッチに近づくよう電極指ピッチが設定されていることを特徴とする請求項１記載の弾性表面波フィルタ。
【請求項８】　前記隣接区間の電極指の幅と隣接区間以外の電極指の幅とが等しいことを特徴とする請求項１乃至５記載の弾性表面波フィルタ。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は弾性表面波フィルタ（以下、ＳＡＷフィルタと称す）に関し、特に１次と３次の縦モードを利用した１次－３次縦結合二重モードＳＡＷフィルタ（以下、二重モードＳＡＷフィルタと称す）の帯域幅及び挿入損失を改善したＳＡＷフィルタに関する。
【０００２】
【従来の技術】近年、ＳＡＷフィルタは通信分野で広く利用され、高性能、小型、量産性等の優れた特徴を有することから特に携帯電話機等に多く用いられている。その中でも携帯電話機のＲＦ部に用いられるフィルタの１つに、３個のＩＤＴ電極を近接配置して、１次と３次の縦モードを強勢に励振し、これらを利用して構成した広帯域の二重モードＳＡＷフィルタがある。
【０００３】図１４は従来の二重モードＳＡＷフィルタの基本的構成を示す平面図であって、圧電基板１１の主表面上に表面波の伝搬方向に沿ってＩＤＴ電極１２、１３、１４を近接配置すると共に、これらＩＤＴ電極１２、１３、１４の両側にグレーティング反射器（以下、反射器と称す）１５ａ、１５ｂをそれぞれ配設する。そして、ＩＤＴ電極１２、１３、１４はそれぞれ互いに間挿し合う複数の電極指を有する一対のくし形電極から形成され、中央のＩＤＴ電極１２の一方のくし形電極を入力端子ＩＮにワイヤボンディング等を用いて接続すると共に、他方のくし形電極を接地する。さらに、両外側のＩＤＴ電極１３、１４のくし形電極同士をそれぞれ接続すると共に、接続した一方を出力端子ＯＵＴに接続し、他方を接地して二重モードＳＡＷフィルタを構成する。
【０００４】図１５に示すようにＩＤＴ電極１２、１３、１４のそれぞれの電極指ピッチはいずれもＬｔ（電極周期をλとすると、λ＝２Ｌｔ）とし、反射器１５ａ、１５ｂの電極指ピッチはＬｒとする。そして、ＩＤＴ電極１３、１４と反射器１５ａ、１５ｂとの相隣接する電極指同士の中心間間隔Ｌｔｒは、弾性表面波の連続性を考慮してλ／２に設定するのが一般的である。また、反射器１５ａ、１５ｂのピッチＬｒは、これらが形成するストップバンドＢｓが、ＩＤＴ電極１２、１３、１４によって励起される１次と３次モードが形成する二重モードＳＡＷフィルタのパスバンドＢを包含するように設定するのが一般的である。このような構成とすることにより、１次、３次モードのＱ値を大きくすることができ、フィルタとしては通過域の平坦化と挿入損失の低減とが可能となる。
【０００５】近年、携帯電話の急速な普及に対応して収容するチャネル数を増大すべく、ＲＦフィルタの帯域幅の拡大が要求されるようになった。この要求を満たすために種々の改善がなされたが、その１つに、図１５に示すように中央のＩＤＴ電極１２と両外側のＩＤＴ電極１３、１４との相隣接する電極指同士の中心間間隔Ｌｔｔをλ／２より小さくすることにより、二重モードＳＡＷフィルタの帯域幅が増大することが実験的に見いだされた。図１６は電極指幅（ライン幅）ＬｎとスペースＳｔとの比を５０：５０（Ｌｎ＝Ｓｔ＝λ／４）とし、Ｌｔｔをλ／４と設定した場合の電極パターンの平面図であって、中央のＩＤＴ電極と両外側のＩＤＴ電極との相隣接する電極同士が互いに接した電極パターン図である。相隣接ＩＤＴ電極の境界部分にて２つの電極指が接して１つの電極指を構成しているため、そのライン幅はλ／２と幅広となる。現在では、二重モードＳＡＷフィルタの帯域幅の最大化を図るために、中心間間隔Ｌｔｔ

を０．２λから０．３λの間に設定するのが一般的であり、図１７は現在一般的に用いられている二重モードＳＡＷフィルタの電極パターンである。幅広の電極指は図１７に示すように、中央のＩＤＴ電極１２’の両端に配置しても、また、両外側のＩＤＴ電極１３’、１４’の最内側に配置してもよく、全体の電極パターンとしては中央のＩＤＴ電極１２’の中心に対して対称に構成することが望ましい。

【０００６】

【発明が解決しようとする課題】しかしながら、図１７に示すような従来の二重モードＳＡＷフィルタにおいては、中央のＩＤＴ電極１２’の両端にある幅広の電極指Ｑ１、Ｑ２が、他の電極指幅（ライン幅）より広く設定されているため、その部分において電極周期が異なることにより、励起される表面波の連続性が損なわれることになる。そのため、二重モードＳＡＷフィルタの挿入損失が低減できないという問題があった。本発明は上記問題を解決するためになされたものであって、帯域幅を拡大すると共に挿入損失を低減した二重モードＳＡＷフィルタを提供することを目的とする。

【０００７】

【課題を解決するための手段】上記目的を達成するために本発明に係る弾性表面波フィルタの請求項１記載の発明は、圧電基板の主表面上に表面波の伝搬方向に沿って複数のＩＤＴ電極を互いに近接するよう配置すると共に、これらＩＤＴ電極の両外側にグレーティング反射器を配置した縦結合多重モード弾性表面波フィルタであって、相隣接したＩＤＴ電極の隣接部近傍（隣接区間）においては、ＩＤＴ電極の隣接区間以外の部分の電極指ピッチ（標準ピッチ：Ｌｔ）に比べ狭いピッチにて電極指が配列されていることを特徴とする弾性表面波フィルタである。請求項２記載の発明は、圧電基板の主表面上に３つのＩＤＴ電極を近接配置して構成した１次－３次縦結合二重モード弾性表面波フィルタであることを特徴とする請求項１記載の弾性表面波フィルタである。請求項３記載の発明は、中央に配置されたＩＤＴ電極よりも外側に配置されたＩＤＴ電極側に広く前記隣接区間が設定されていることを特徴とする請求項２記載の弾性表面波フィルタである。請求項４記載の発明は、前記隣接区間の電極指本数を４本とし、その電極指ピッチＬｔ４と隣接区間以外の電極指ピッチＬｔとの比　Ｌｔ４／Ｌｔが０．８０００≦Ｌｔ４／Ｌｔ≦０．９１１１であることを特徴とする請求項１乃至３記載の弾性表面波フィルタである。請求項５記載の発明は、前記隣接区間の電極指本数を８本とし、その電極指ピッチＬｔ８と隣接区間以外の電極指ピッチＬｔとの比Ｌｔ８／Ｌｔが０．８９４１≦Ｌｔ８／Ｌｔ≦０．９５３０であることを特徴とする請求項１乃至３記載の弾性表面波フィルタである。請求項６記載の発明は、前記隣接区間の電極指の幅と電極指間のスペース幅とが等しいことを特徴とする請求項１乃至５記載の弾性表面波フィルタである。請求項７記載の発明は、前記隣接区間の中央部分の電極指ピッチが最も狭く、外に向かって行くほど隣接区間以外の電極指ピッチに近づくよう電極指ピッチが設定されていることを特徴とする請求項１記載の弾性表面波フィルタである。請求項８記載の発明は、前記隣接区間の電極指の幅と隣接区間以外の電極指の幅とが等しいことを特徴とする請求項１乃至５記載の弾性表面波フィルタである。

【０００８】

【発明の実施の形態】以下本発明を図面に示した実施の形態に基づいて詳細に説明する。図１は本発明に係る二重モードＳＡＷフィルタの電極パターン構成を示す平面図であって、圧電基板（図示しない）上にＳＡＷの伝搬方向に沿って３つのＩＤＴ電極１、２、３を近接配置すると共に、それらの両側に反射器４ａ、４ｂを配設する。ＩＤＴ電極１、２、３はそれぞれ互いに間挿し合う複数の電極指を有する一対のくし形電極から形成され、中央のＩＤＴ電極１の一方のくし形電極を入力端子ＩＮに接続すると共に、他方のくし形電極を接地する。さらに、両外側のＩＤＴ電極２、３のくし形電極同士をそれぞれ接続すると共に、接続した一方を出力端子ＯＵＴに接続し、他方を接地して二重モードＳＡＷフィルタを構成する。本発明の二重モードＳＡＷフィルタは中央のＩＤＴ電極１の中心に対して対称に構成されている。

【０００９】本発明の特徴は中央のＩＤＴ電極１と、両外側のＩＤＴ電極２、３との相隣接する近傍（以下、隣接区間と称す）、即ち図１にＬｉにて示す区間において、隣接区間以外における電極指ピッチよりも電極指ピッチを狭くしたことにより、二重モードＳＡＷフィルタの帯域幅が広くなり、且つ挿入損失が低減されるところにある。

【００１０】本発明の要部を、図面を用いて説明する。図２（ａ）は図１７に示した従来の二重モードＳＡＷフィルタの電極パターンの中央ＩＤＴ電極１２’と、外側のＩＤＴ電極１４’との隣接部を拡大して示した平面図、同図（ｂ）はその断面図で白抜きの電極指を、例えば（＋）側とし、模様のある電極指を（－）側とする。図２（ａ）に示すように中央ＩＤＴ電極１２’の幅広電極指ｆ２の中央に対して、対称にｆ１からｆ３までの３本の電極指を選び、該電極指列の両側にある電極指ｆａの右端の位置から、ＩＤＴ電極１４’の電極指ｆｂの左端の位置までこの区間をＬ４とする。ここでは、弾性表面波の連続性が崩れる幅広の電極指ｆ２の中心から左右対称に隣接区間を選ぶことにする。また、隣接区間以外の電極指ピッチをＬｔとする。この隣接区間Ｌ４にある３本の電極指ｆ１、ｆ２、ｆ３に代えて、図２（ｃ）に示すように新たに４本の電極指Ｆ１、Ｆ２、Ｆ３、Ｆ４を均等な電極指ピッチＬｔ４にて形成する。当然のことながらＬｔ４＜Ｌｔとなる。図２（ｄ）は同図（ｃ）の断面図と、その極性とを表す。このように隣接区間Ｌ４

を均等な電極指ピッチの４本の電極指で置換した場合、弾性表面波の連続性が改善される。

【００１１】以上の実施例は、図１７に示すＩＤＴ電極同士の隣接区間にある電極指３本に代えて、新たに形成したライン－スペース比を１：１とした４本の電極指で置換した例である。これは先に述べたように図１８（ａ）に示す如く基本形（図１５）連続する電極指ピッチＬｔとＬｔｔとが等しく構成されており、表面波が連続して伝搬できるような構造となっていたが、同図（ｂ）に示すように相隣接するＩＤＴ電極同士を近接配置したことによって、通過域を広げることができるものの表面波の連続性が損なわれることになった。そこで、電極指ピッチが狭まった量（Ｌｔ－Ｌｔｔ）をオフセット量Ｌｏｆとすると、オフセット量Ｌｏｆを一カ所に集中さて幅広の電極指を一本配置するのではなく、隣接区間Ｌ４に均等に狭ピッチの電極指を均等に分散配置することにより、表面波の連続性を改善したところに本発明の特徴がある。

【００１２】図３の破線で示すフィルタ特性は、従来（図１７）の電極パターンを用いてＰＤＣ用のＲＦフィルタ（ＰＤＣ用デュアルフィルタの低周波ＲＦフィルタ）を試作した場合のパスバンド特性であって、圧電基板に３９°Ｙ－Ｘ $LiTaO_3$ を用い、中心周波数を877.5MHz、帯域幅１５MHzに設定し、電極指とスペースの比を５０：５０、電極指中心間間隔Ｌｔｔをλ／４、中央のＩＤＴ電極１２’の対数を28.5対、両外側のＩＤＴ電極１３’、１４’の対数を共に19.5対、交叉長Ｗを３３λ（λは電極周期）、反射器１５’ａ、１５’ｂの本数をそれぞれ90本とした場合である。これに対し実線で示すフィルタ特性は図２（ｃ）、（ｄ）に示したように隣接区間Ｌ４に在った３本の電極指を、均等電極指ピッチＬｔ４にて形成した４本の電極指とスペースとで置換した場合のパスバンド特性である。新たに形成した４本の電極指のピッチ比α＝Ｌｔ４／Ｌｔはα＝0.8773となる。更に本発明を適用する場合には、基準とする二重モードＳＡＷフィルタの電極指間隔Ｌｔｔとしてこれまで一般的に用いられていた$0.2\lambda \leqq Ltt \leqq 0.3\lambda$の範囲のみならず、$0.1\lambda \leqq Ltt \leqq 0.3\lambda$の範囲で通過帯域幅の広帯域化が実現できることが判明した。よって、この例に於いて電極指のピッチ比αとして設定し得る範囲は０．８０００$\leqq\alpha\leqq$０．９１１１となる。図３から明らかなように、第１の実施例になる二重モードＳＡＷフィルタは、従来のフィルタに比べて帯域幅が広がると共に挿入損失が低減されることが判明した。

【００１３】図４の破線で示すフィルタ特性は、従来（図１７）の電極パターンを用いてＡＭＰＳ用のＲＦフィルタを試作した場合のパスバンド特性であって、圧電基板に３９°Ｙ－Ｘ $LiTaO_3$ を用い、中心周波数を881.5MHz、帯域幅２５MHzに設定し、ライン幅とスペースとの比を５０：５０、電極指中心間間隔Ｌｔｔを０．３λ、中央のＩＤＴ電極１２’の対数を19.5対、両側のＩＤＴ電極１３’、１４’の対数を13.5対、交叉長Ｗを45λ（λは電極周期）、反射器１５’ａ、１５’ｂの本数をそれぞれ120本とした二重モードＳＡＷフィルタを２段縦続接続した場合のフィルタ特性である。これに対し実線で示すパスバンド特性は、図２（ｃ）、（ｄ）に示したように隣接区間Ｌ４を均等電極指ピッチＬｔ４の電極指４本とスペースとで置換した二重モードＳＡＷフィルタを２段縦続接続した場合のフィルタ特性である。新たに形成した４本の電極指のピッチ比α＝Ｌｔ４／Ｌｔはα＝0.889である。図４からも本発明の効果として帯域幅の拡大と挿入損失の低減とが確認できる。

【００１４】図５は本発明に係る第２の実施の形態を示す例であって、図５（ａ）は図１７に示した従来の二重モードＳＡＷフィルタの中央のＩＤＴ電極１２’と、外側のＩＤＴ電極１４’との要部を拡大して示した電極パターンの平面図、同図（ｂ）はその断面図である。図５（ａ）に示すように中央ＩＤＴ電極１２’の幅広電極指ｆ４の中央を基準として、対称にｆ１からｆ７までの７本の電極指を選び、該電極指列の両側にある電極指ｆａの右端の位置から、ＩＤＴ電極１４’の電極指ｆｂの左端の位置までの区間をＬ８とする。隣接区間Ｌ８の選定は幅広の電極指ｆ４の中心とし、左右対称に選ぶものとする。この隣接区間内Ｌ８にある７本の電極指に代えて、均等な電極指ピッチＬｔ８の８本の電極指Ｆ１、Ｆ２、Ｆ３、Ｆ４、Ｆ５、Ｆ６、Ｆ７、Ｆ８を形成する。図５（ｄ）は同図（ｃ）の断面図とその極性を表している。このように幅広を含む隣接区間Ｌ８の電極を等ピッチの電極指列で代えることにより、隣接区間Ｌ８における弾性表面波の連続性が改善されることになり、フィルタの挿入損失が改善されることが期待される。

【００１５】図６の破線で示すフィルタ特性は、従来（図１７）の電極パターンを用いてＰＤＣ用のＲＦフィルタを試作した場合のフィルタの特性であって、図３に示した諸定数を用いている。同図の実線で示すフィルタ特性は図５（ｃ）、（ｄ）に示したように、ＩＤＴ電極同志が相隣接する隣接区間Ｌ８に電極指を１本増やすと共に、均等電極指ピッチＬｔ８の８本の電極指列で置換した場合のパスバンド特性を示している。電極指のピッチ比α＝Ｌｔ８／Ｌｔは0.9235である。前述したように、基準となる二重モードＳＡＷフィルタの電極指間間隔Ｌｔｔを$0.1\lambda \leqq Ltt \leqq 0.3\lambda$とすると、電極指のピッチ比$\alpha$の設定し得る範囲は０．８９４１$\leqq$Ｌｔ８／Ｌｔ$\leqq$０．９５３０となる。図６から明らかなように従来の二重モードＳＡＷフィルタ（破線）に比べ、第２の実施例の二重モードＳＡＷフィルタ（実線）では、フィルタ特性通過帯域も広がり、挿入損失も低減していることが分かる。また、図３と６とを比較すると８本の電極指で置換したフィルタの方が４本のものより、パスバンド

は広く、挿入損失は小さくなっていることが判明した。これは表面波の連続性がより改善されたものと推測される。

【００１６】図７は従来例（図１７）を上段に、第３の実施例の形態を下段に断面図にて示したものである。幅広の電極指ｆ５を中心として図中左右に同数の電極指４本づつ計９本を選び、該電極指列の両側にある電極指ｆ１の左端の位置から、電極指ｆ９の右端の位置までの区間をＬ１０とする。該隣接区間Ｌ１０にある電極指ｆ１からｆ９の９本の電極指に代えて、新たに電極指Ｆ１からＦ１０の１０本の電極指を形成する。その電極指ピッチは図７の下段に示すよに、隣接区間Ｌ１０の左右から対称にピッチｐ１、ｐ２、ｐ３と選び、ｐ１＞ｐ２＞ｐ３と中央部分の電極指ピッチが最も狭く、外に向かって行くほど隣接区間以外の電極指ピッチに近づくように電極指ピッチを設定する。具体的にはＶ字型あるいはＵ字型、または逆台形型（ｐ１＞ｐ２＝ｐ３）となるように設定する。隣接区間Ｌ１０以外の電極ピッチＬｔに対し、隣接区間Ｌ１０ピッチｐｉの変化ができるだけ少なくなるように設定する方が弾性表面波の連続性が損なわれないもと推測される。

【００１７】図８の破線で示すフィルタ特性は、従来例（図１７）の電極パターンを用いてＰＤＣ用のＲＦフィルタ（ＰＤＣデュアルフィルタの高周波ＲＦフィルタ）を試作した場合のパスバンド特性であって、圧電基板に３９°Ｙ－Ｘ $LiTaO_3$ を用い、中心周波数を1489.0MHz、帯域幅２４MHzに設定し、ラインとスペースとの比を６０：４０、電極指中心間間隔Ｌｔｔを０．３λ、中央のＩＤＴ電極１２’の対数を22.5対、両側のＩＤＴ電極１３’、１４’の対数を15.5対、交叉長Ｗを３０λ（λは電極周期）、反射器１５’ａ、１５’ｂの本数をそれぞれ90本とした場合のフィルタ特性である。これに対し実線で示すパスバンド特性は図７の下段に示したように、隣接区間Ｌ１０内にある９本の電極指を、電極指ピッチｐｉ（ｉ＝１，２，３）にて形成した１０本の電極指で置換した場合のパスバンド特性である。電極指ピッチｐ１、ｐ２、ｐ３は、元の電極指ピッチＬｔに対して電極指ピッチ比αｉを用いて、ｐｉ＝αｉ・Ｌｔとあらわせる。図８の例ではピッチ比αｉは逆台形状でそれぞれ0.9667、0.9333、0.9333とした。ピッチの変化としてはこれ以外にＶ字形（１次式、｜ａ（ｘ－ｂ）｜）、Ｕ字形（２次式、ａ（ｘ－ｂ）^{2}）等が考えられる。図８から明らかなように本発明の二重モードＳＡＷフィルタは、従来のフィルタに比べて帯域幅が広がると共に挿入損失が低減されることが分かった。

【００１８】図９は第４の実施例の形態を示す図であって、同図（ａ）は基準となる従来例（図１７）、同図（ｂ）、（ｃ）は第４の実施例の電極パターンの構成を示す断面図と、平面図である。今までの実施例では電極指を１本増やす隣接区間として、幅広の電極指を中心として左右対称に隣接区間を決めていたが、本例では隣接区間の中心の選び方を幅広の中心から外側のＩＤＴ電極の方へずらして、外側のＩＤＴ電極の電極指を多く含むように選んだ例である。図９（ａ）に示すように中央のＩＤＴ電極１２’の電極指ｆａの右端の位置から、外側のＩＤＴ電極１４’の電極指ｆｂの左端の位置までの区間をＬ４とする。この隣接区間Ｌ４内には幅広の電極指ｆ１と、電極指ピッチＬｔの電極指ｆ２、ｆ３があり、これら３本の電極指ｆ１、ｆ２、ｆ３に代えて、均等な電極指ピッチＬｔ４の４本の電極指Ｆ１、Ｆ２、Ｆ３、Ｆ４を形成する。当然のことながらＬｔ４＜Ｌｔとなり、電極指ピッチ比はα４＝Ｌｔ４／Ｌｔ＜１となる。

【００１９】図１０の破線で示すのフィルタ特性は、図２（ｃ）、（ｄ）に示した本発明に係る４本の均等電極指ピッチで構成した二重モードＳＡＷフィルタのパスバンド特性で、諸定数は図４に示した定数を用いた。同図の実線で示すフィルタ特性が第４の実施例を用いた二重モードＳＡＷフィルタのものであって、図９（ｂ）、（ｃ）に示したように隣接区間Ｌ４に存在した電極指を３本を取り去り、１本増やして４本の電極指を均等ピッチにて形成した場合のパスバンド特性である。終端インピーダンスがミスマッチングしているために、パスバンド内にリップルが生じているが、電極対数を適正に設定することによりパスバンドを平坦にすることができる。この例にように電極指ピッチを狭くする隣接区間は、必ずしも幅広の電極指を中心として対称に選ぶ必要はなく、外寄りのＩＤＴ電極の方へ偏ってもよい。

【００２０】図１１（ａ）は基準となる従来（図１７）の二重モードＳＡＷフィルタの電極パターンを示す断面図であり、（ｂ）は本発明に係る第５の実施例の形態を示す電極パターンの断面図である。図１１（ａ）の幅広の電極指を中心として両隣の電極指ｆ１に左端の位置から、電極指ｆ３の右端に位置までの区間をＬ３とする。この隣接区間Ｌ３にある３本の電極指ｆ１、ｆ２、ｆ３に代えて、新たに４本の電極指Ｆ１、Ｆ２、Ｆ３、Ｆ４を形成する。何れの電極指もライン幅は元のライン幅Ｌｎのままとし、電極指ｆ１はそのままＦ１とし、電極指ｆ３はそのままＦ４とする。そして、電極指ｆ２に代えてライン幅Ｌｎの２本の電極指Ｆ２、Ｆ３を等ピッチに配置する。それ故、電極指間のスペースＳ２が基準のスペース幅Ｓｔと比べて狭くなる。即ち、Ｓ２は次式から求めることができる。

$$３Ｓ２＝２Ｓｔ＋（Ｌｔｔ－λ／４）\cdots\cdots\cdots（１）$$

つまり、従来のオフセットが一カ所に集中していたものを３カ所に分散させ、表面波の連続性の改善を図ったものである。

【００２１】図１２の破線で示すフィルタ特性は、従来（図１７）の電極パターンを用いてＡＭＰＳ用のＲＦフィルタを試作した場合のパスバンド特性であって、圧電

基板に39°Y-X $LiTaO_3$ を用い、中心周波数を881.5MHz、帯域幅25MHzに設定し、電極指とスペースの比を50：50、電極指中心間間隔Ｌｔｔを0．3λ、中央のＩＤＴ電極１２’の対数を19.5対、両側のＩＤＴ電極１３’、１４’の対数を13.5対、交叉長Ｗを45λ（λは電極周期）、反射器１５’ａ、１５’ｂの本数をそれぞれ120本とした二重モードＳＡＷフィルタを２段縦続接続したフィルタのパスバンド特性である。これに対し実線で示すフィルタ特性は、基準の電極指間隔Ｌｔｔを0.275λとした上で、図１１（ｂ）に示すように隣接区間Ｌ３の電極指ピッチＬ’ｔ４を0.425λとした二重モードＳＡＷフィルタを２段縦続接続したフィルタのパスバンド特性である。ここでスペースＳ２は0.175λとなる。図１２からも本発明の効果である帯域幅の拡大と挿入損失の低減が明らかである。また、図１３は減衰域のフィルタ特性を示す図で、破線は従来（図１７）のフィルタの特性、実線が本発明のフィルタ特性を示す。低域側において本発明のフィルタの特性が若干改善されていることが分かる。

【００２２】

【発明の効果】本発明は、以上説明したように構成したので、本発明に係る二重モードＳＡＷフィルタにおいては、その通過帯域幅が広がると共に、挿入損失を低減するという優れた効果を表す。

【図面の簡単な説明】

【図１】本発明に係る二重モードＳＡＷフィルタの電極パターンの構成を示す平面図である。

【図２】（ａ）、（ｂ）は基準となる従来の二重モードＳＡＷフィルタの要部の拡大平面図とその断面図、（ｃ）、（ｄ）は本発明に係る第１の実施例の要部の拡大平面図とその断面図である。

【図３】本発明に係る第１の実施例の電極パターンを用いて試作したＰＤＣ用ＲＦフィルタのパスバンド特性である。

【図４】本発明に係る第１の実施例の電極パターンを用いて試作したＡＭＰＳ用ＲＦフィルタのパスバンド特性である。

【図５】（ａ）、（ｂ）は基準となる従来の二重モードＳＡＷフィルタの要部の拡大平面図とその断面図、（ｃ）、（ｄ）は本発明に係る第２の実施例の要部の拡大平面図とその断面図である。

【図６】第２の実施例の電極パターンを用いて試作したＰＤＣ用ＲＦフィルタのパスバンド特性である。

【図７】上段は基準となる従来の二重モードＳＡＷフィルタの要部の拡大断面図であり、下段は本発明に係る第３の実施例の要部の拡大断面図である。

【図８】第３の実施例の電極パターンを用いて試作したＰＤＣ用ＲＦフィルタのパスバンド特性である。

【図９】（ａ）は基準となる従来の二重モードＳＡＷフィルタの要部の拡大断面図、（ｂ）、（ｃ）は本発明に係る第４の実施例の要部の拡大断面図と平面図である。

【図１０】実線は第４の実施例の電極パターンを用いて試作したフィルタのパスバンド特性、破線は図２に示す第１の実施例の電極パターンを用いて試作したフィルタのパスバンド特性である。

【図１１】（ａ）は基準となる従来の二重モードＳＡＷフィルタの要部の拡大断面図、（ｂ）は本発明に係る第５の実施例の要部の拡大断面図である。

【図１２】実線は本発明に係る第５の実施例の電極パターンを用いて試作したフィルタのパスバンド特性、破線は従来の電極パターンを用いたときのパスバンド特性である。

【図１３】実線は本発明に係る第５の実施例の電極パターンを用いて試作したフィルタの減衰域特性、破線は従来の電極パターンを用いたときの減衰域特性である。

【図１４】従来の二重モードＳＡＷフィルタの構成を示す基本の電極パターンの平面図である。

【図１５】従来の二重モードＳＡＷフィルタの構成を示す基本の電極パターンの各部の寸法を示す図である。

【図１６】通過帯域幅を拡大すべく構成した従来の二重モードＳＡＷフィルタの構成を示す電極パターン図である。

【図１７】図１６を実用に供するようにした従来の二重モードＳＡＷフィルタの構成を示す電極パターン図である。

【図１８】（ａ）は従来の二重モードＳＡＷフィルタの基本形の電極パターンを示す断面図、帯域幅を拡大した場合の電極パターンの断面図と、各部の寸法とを示す。

【符号の説明】

１、２、３・・ＩＤＴ電極

４ａ、４ｂ・・反射器

Ｌｉ、Ｌ３、Ｌ４、Ｌ８、Ｌ１０・・２つのＩＤＴ電極の隣接する隣接区間

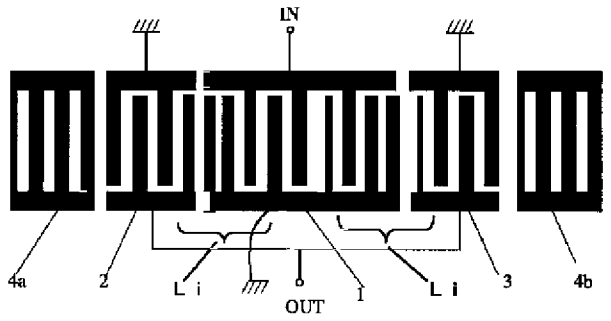
ｆａ、ｆｂ、ｆ１、ｆ２ｆ３、ｆ４、ｆ５、ｆ６、ｆ７、ｆ８、ｆ９・・電極指

Ｆ１、Ｆ２、Ｆ３、Ｆ４、Ｆ５、Ｆ６、Ｆ７、Ｆ８、Ｆ９、Ｆ１０・・電極指

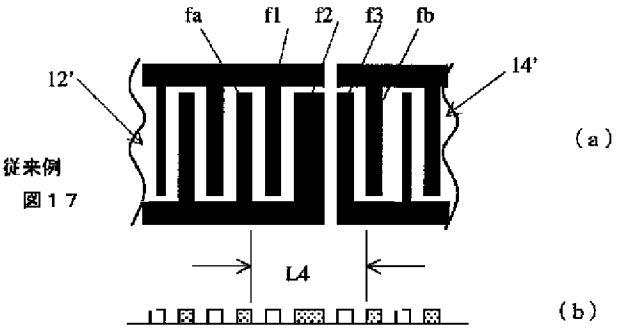
ｐ１、ｐ２、ｐ３・・電極のピッチ

Ｓ２・・スペース

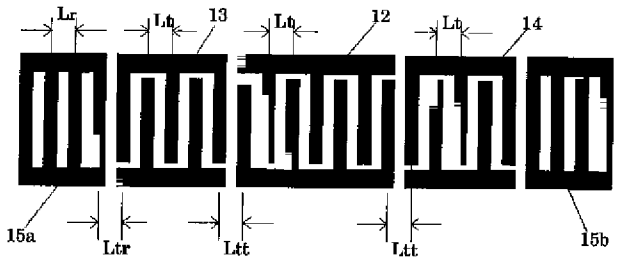
【図１】

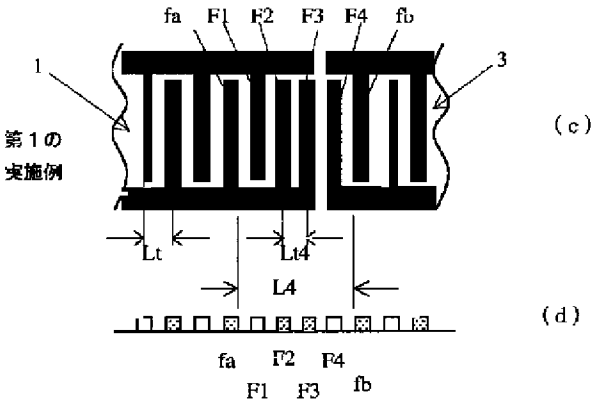


【図２】

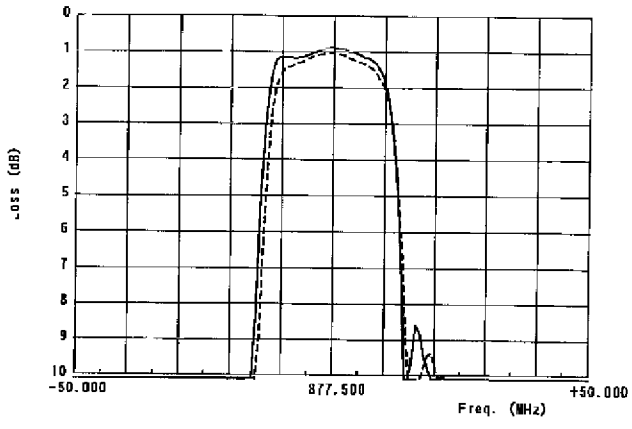


【図１５】

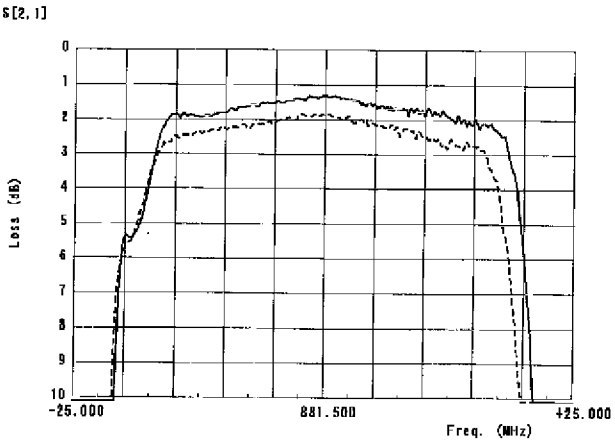




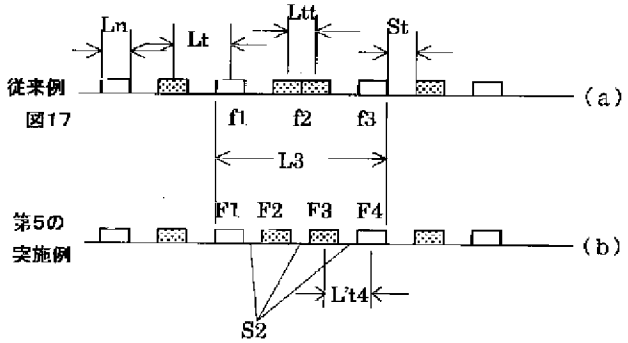
【図３】



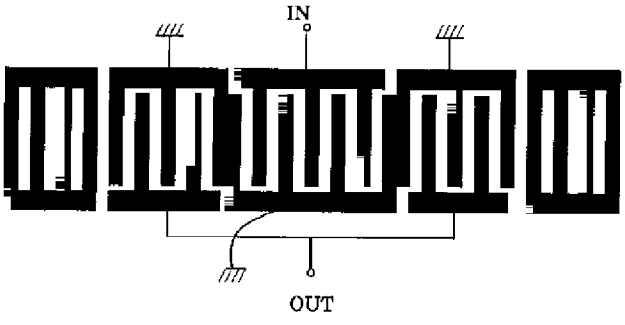
【図４】



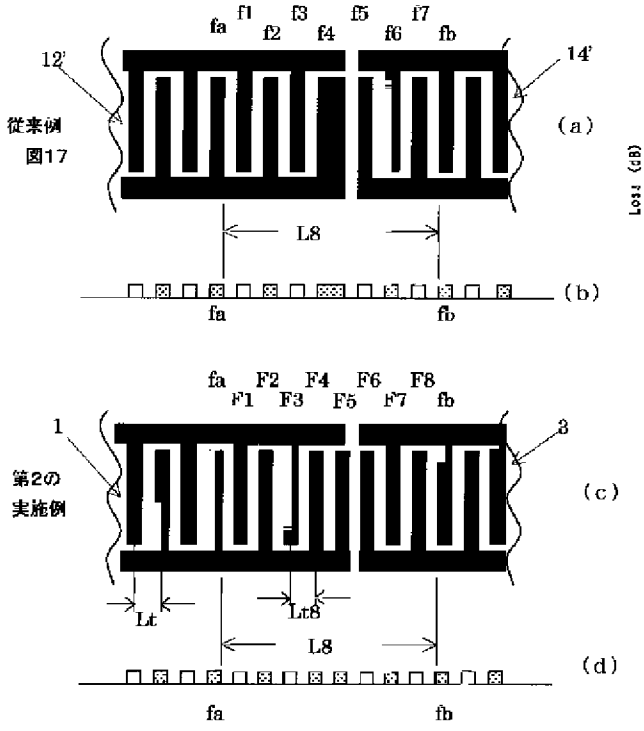
【図１１】



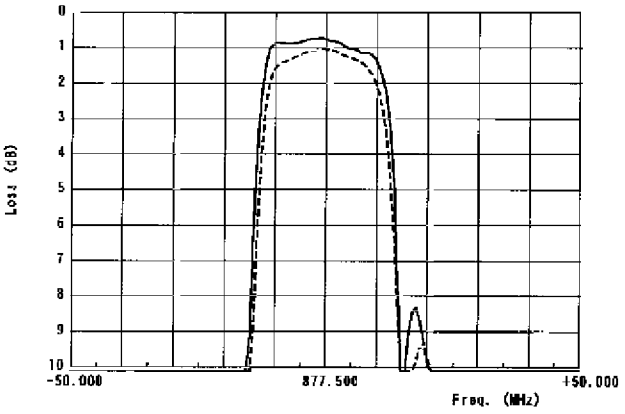
【図１６】



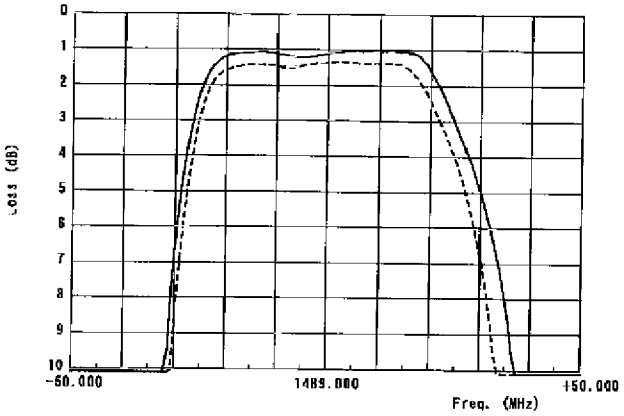
【図5】



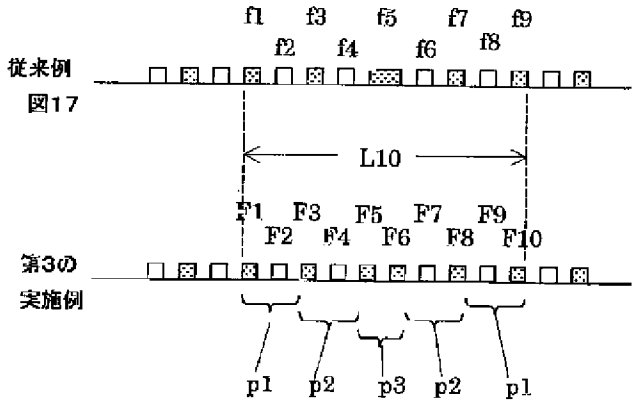
【図6】



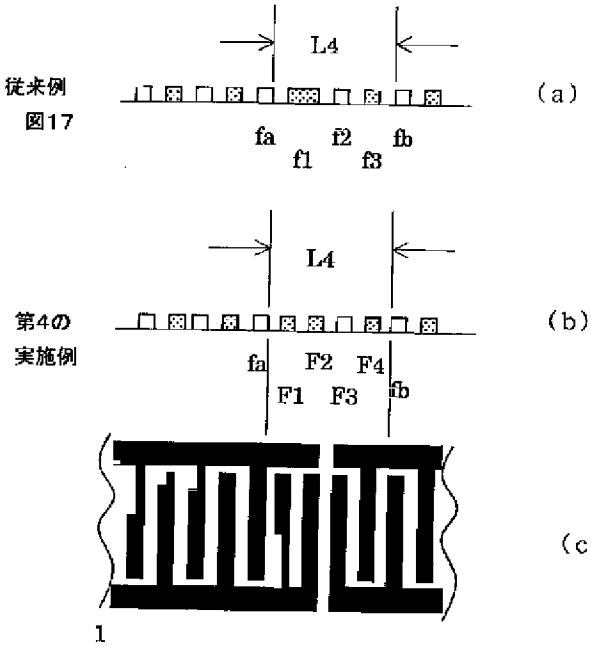
【図8】



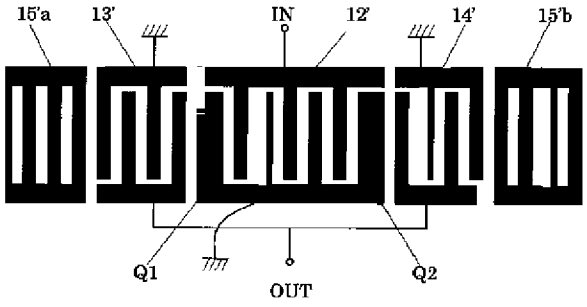
【図7】



【図9】



【図17】



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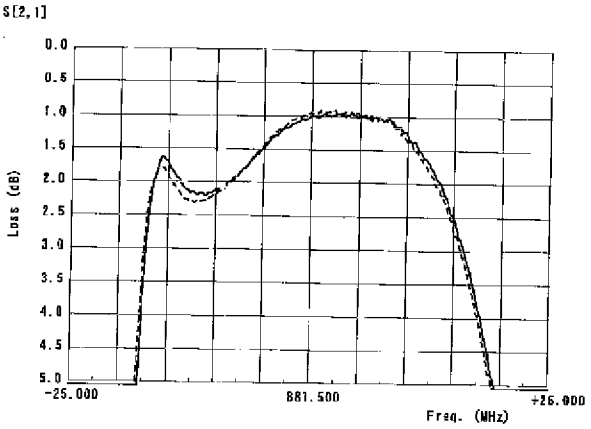
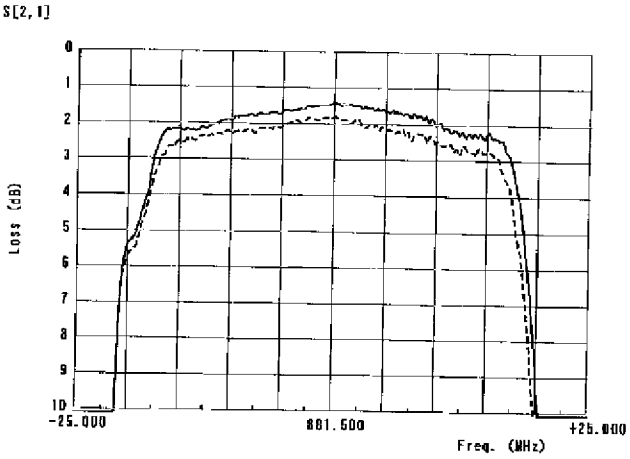
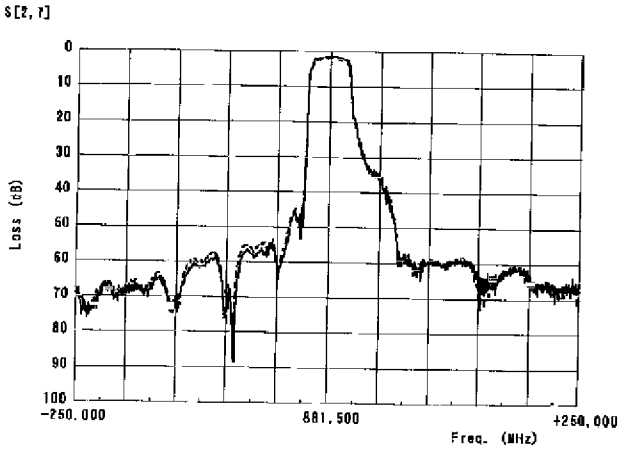
【図10】



【図12】



【図13】



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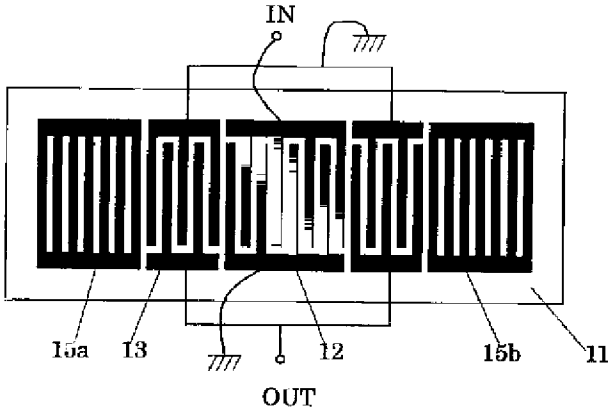

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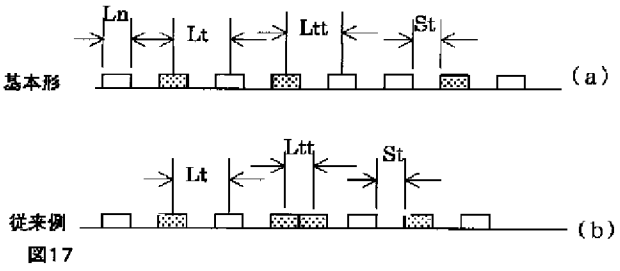

図17